

# The effectiveness of kinematics worksheets based instructions virtual phenomenon to improve science process skills and conceptual understanding of pre-service physics teachers during the COVID-19 pandemic

Cite as: AIP Conference Proceedings **2468**, 020014 (2022); <https://doi.org/10.1063/5.0102510>  
Published Online: 29 December 2022

Yanti Sofi Makiyah, Adam Malik, Dwi Sulistyaningsih, et al.



[View Online](#)



[Export Citation](#)



## APL Quantum

**CALL FOR APPLICANTS**

### Seeking Editor-in-Chief

# The Effectiveness of Kinematics Worksheets Based Instructions Virtual Phenomenon to Improve Science Process Skills and Conceptual Understanding of Pre-Service Physics Teachers During The COVID-19 Pandemic

Yanti Sofi Makiyah<sup>1, a)</sup>, Adam Malik<sup>2, b)</sup>, Dwi Sulistyarningsih<sup>1, c)</sup>, and Ernita Susanti<sup>1, d)</sup>

<sup>1</sup>Physics Education, Universitas Siliwangi, Jl. Siliwangi No. 24, Tasikmalaya 46115, Indonesia

<sup>2</sup>Physics Education, Universitas Islam Negeri Sunan Gunung Djati Bandung, Jl. A.H Nasution No. 105, Bandung 40614, Indonesia

<sup>a)</sup>Corresponding author: yanti.sofi@unsil.ac.id

<sup>b)</sup>adammalik@uinsgd.ac.id

<sup>c)</sup>dwi.sulistyarningsih@unsil.ac.id

<sup>d)</sup>ernita.susanti@unsil.ac.id

**Abstract.** Science process skills and conceptual understanding of pre-service physics teachers were in the low category. This research was conducted to solve this problem by using worksheets based on virtual phenomenon instructions. This research aims to determine the effectiveness of worksheets and improvement of science process skills and understanding of concepts in pre-service physics teachers during the COVID-19 pandemic. The design of this research is one group pretest-posttest with purposive sampling are pre-service physics teachers who take mechanics course in the academic year 2020/2021 (n = 81) consists of 21 males and 60 females. There are 6 conceptual understanding questions for pretest and posttests based on Bloom's Taxonomy (C2, C3, C4). Assessment of science process skills includes indicators of observing, classifying, interpreting, predicting and communicating consist of 5 questions. The data analysis technique uses the effect size and N-Gain score. Based on the result of this research, it was found that the improvement of science process skills and conceptual understanding of pre-service physics teachers reached 0.56 and 0.47 which was categorized as moderate. Effect size for science process skills and conceptual understanding are 3.5 and 1.9 are categorized very high so it can be concluded that the effectiveness of kinematics worksheets-based instruction virtual phenomenon is very significant to improve science process skills and conceptual understanding of pre-service physics teachers.

## INTRODUCTION

One of the basic competencies needed by pre-service physics teachers are science process skills and conceptual understanding [1]. These two competencies are strong basis so that pre-service physics teachers are ready to become professional physics teachers in implementing learning later to their students in unexpected situations such as during the current Covid-19 pandemic [2]. Therefore, it is important to train science process skills and conceptual understanding in physics education in 21st century learning [3].

Researchers conducted observations by giving 6 questions about understanding concepts and 5 questions about science process skills before conducting mechanics lectures in the academic year 2020/2021. Based on the results of observations, it is known that Science Process Skills (SPS) and Conceptual Understanding (CU) of pre-service physics

teachers are still low on the kinematics concept. This is because learning during the COVID-19 pandemic has not been optimal in training science process skills. In addition, the lack of exercises carried out by pre-service physics teachers also resulted in low conceptual understanding because the concepts were still memorized without being trained in solving new questions. This is a problem that must be resolved immediately by finding the right solution, one of which is making a worksheet. Several previous studies have stated that virtual simulations can improve understanding of the concept of direct current electrical circuits [4]. Other studies have also stated that worksheets integrated by terrarium media global warming materials can improve science process skills reached N-gain average 0.7 with high criteria. Worksheet was chosen to be developed as learning material in this research because worksheet can support the effectivity of learning based science process skill [5]. The next studies stated that virtual lab worksheets very effective on student learning outcomes on sound wave materials [6]. The results of other studies suggest that worksheets can improve students' conceptual understanding of acid-base titration [7].

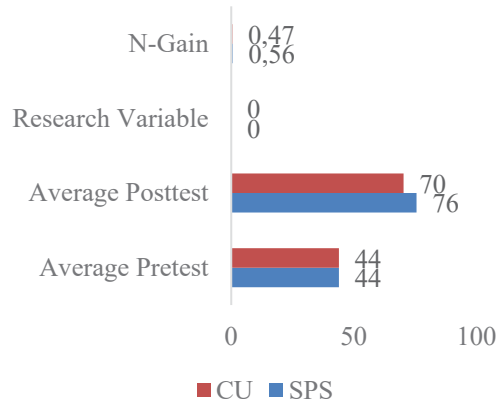
Based on this background, researchers are interested in making kinematics worksheets with instructions that are easy to understand and suitable for use in online learning. This kinematics worksheets based virtual phenomenon is very suitable for online learning during the Covid-19 pandemic because it presents daily phenomenon to provide an overview of the phenomenon first so that it is easier to understand when answering questions and there is humor in the worksheet, so this worksheet has novelty from previous research. The purpose of this study is to determine the effectiveness of the kinematics of worksheets based instructions virtual phenomenon to improve science process skills and conceptual understanding of pre-service physics teachers.

## METHOD

This research is a quantitative research with an experimental method. The research design is one group pretest-posttest. The population of this research were pre-service physics teachers at Siliwangi University in the academic year 2020/2021. The research was conducted in the mechanics course consisting of 81 pre-service physics teachers with purposive sampling technique consists of 21 males and 60 females. All activities in this research conducted online. The worksheet was sent through Google Classroom in a form of .docx file in purpose the students can answer the questions in the worksheet. Pretest and posttest was assigned through Google Classroom. There are 6 conceptual understanding essay questions for pretest and posttests related to the kinematics phenomenon in daily life. It aimed to assess pre-service physics teacher's understanding of kinematics related concepts based on Bloom's Taxonomy (C2, C3, C4). Assessment of science process skills includes indicators of observing, classifying, interpreting, predicting and communicating consist of 5 essay questions. Improvement of pre-service physics teachers' science process skills and conceptual understanding calculated using the average N-Gain score. The effectiveness of the worksheet is known by calculating the effect size based on the pretest and posttest.

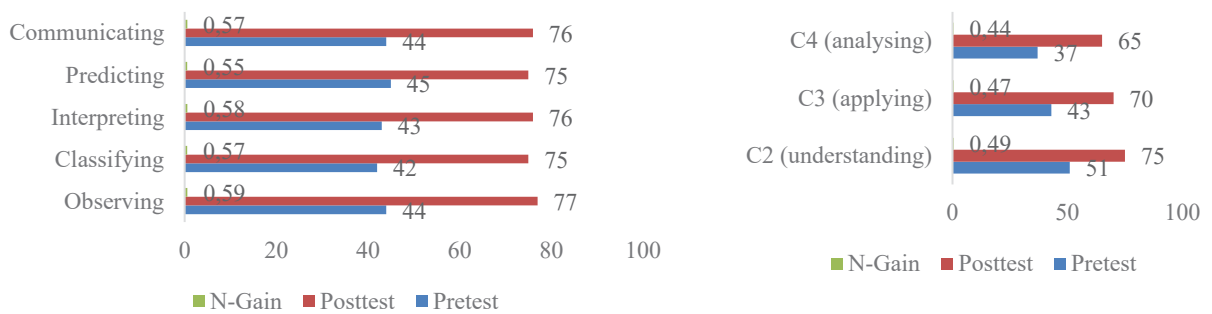
## RESULT AND DISCUSSION

Based on data analysis in Fig. 1, it was found that the improvement of science process skills and conceptual understanding of pre-service physics teachers reached 0.56 and 0.47 which was categorized as moderate. Kinematics worksheets-based instruction virtual phenomenon also very significant and very effective to improve science process skills and conceptual understanding of pre-service physics teachers with effect size for science process skills and conceptual understanding are 3.5 and 1.9 are categorized very high. This result is in accordance with the results of previous studies which state that the virtual phenomenon presented is significant to improve student's conceptual understanding from the low to moderate category [8]. Other studies also show the same results that worksheets are very significant in improving science process skills [9]. The next study also states that worksheets that train pre-service physics teachers' science process skills can improve pre-service physics teachers' conceptual understanding [10]. The results of other studies also show the same results that worksheets improve science process skills through conceptual learning that is relevant in daily phenomena [11].



**FIGURE 1.** The result of CU and SPS

Figure 2 shows the results of the assessment for each indicator of student science process skills. This increase in N-Gain occurs because pre-service physics teachers observing skills are trained through daily virtual phenomena such as observing a person's trajectory or movement when walking, the movement of a runner and a cyclist, the motion of objects thrown vertically, the motion of a car or cart, the movement of a golfer and a shooter, who will shoot at the target when hunting. In classifying skills, pre-service physics teachers are asked to classify vector quantities and scalar quantities on the movement of a subject or object after observing them such as distance, displacement, speed, velocity, and acceleration. In addition, pre-service physics teachers must also classify the types of motion carried out by the subject or object being observed, including uniform straight motion or non-uniform straight motion. Furthermore, for predicting skills, students must predict when and where, the two subjects, namely runners and cyclist, meet in a condition that has been described virtually. In interpreting and communicating skills, pre-service physics teachers are asked to graph the displacement, velocity and acceleration against the time function first then interpret the type of motion of the subject or object then communicate the results by providing conclusions based on the observation of the object's movement graph. The results of this study are in accordance with the results of previous studies which state that worksheets on the topic of ecosystems can improve science process skills in the moderate category [12]. Other studies have also stated the same results that worksheets facilitate the improvement of science process skills in the high category [13].



**FIGURE 2.** The result indicator of SPS and aspect of CU

The results of the assessment for each aspect of pre-service physics teacher's concept understanding are shown in Fig. 2. This increase in conceptual understanding occurs because when pre-service physics teachers answer the worksheet they are required to understand the concept of kinematics first so that the answers given are correct. In addition, pre-service physics teachers must also analyze the type of movement of an object or subject to be able to determine the type of motion, then the daily virtual phenomena presented are also the application of the kinematics concept in daily activities so that it makes it easier for students to apply the concept of kinematics. Other studies have

shown the same results that worksheets are effective in improving conceptual understanding of quadratic functions and equations because they provide clear instructions to students [14]. In addition, the results of other studies also state that virtual learning is more effective in improving students' conceptual understanding of optical material [15].

Figure 3 shows some of the questions in the worksheet. Students see virtual phenomena first then read clear instructions and answer questions in a worksheet. There is humor in the worksheet so that students are entertained and not stressed out during online learning in the COVID-19 pandemic. Through the kinematics worksheets based instructions virtual phenomenon instructions, pre-service physics teachers are trained in observing skills through daily virtual phenomena that are presented and then practice other skills (classifying, interpreting, predicting and communicating) when answering questions in worksheets. In addition, students are trained to understand and analyze the concept of kinematics in daily phenomena so that it will improve students' science process skills and conceptual understanding. Previous study stated that virtual learning using worksheets is very effective in 21st century learning because it can improve students' thinking skills from low to moderate levels [16]. Other studies have also stated that worksheets are also very effective in improving science process skills in science learning [17]. The next studies also state the virtual lab phenomenon as a learning medium that can improve science process skills during the COVID-19 pandemic [18].

**Pay attention to runner and cyclist.**

It is known that  $v_{\text{runner}} = 2 \text{ m/s}$  and  $v_{\text{cyclist}} = 4 \text{ m/s}$

If at first the cyclist and runner were 20 m and the runner moved 5 seconds ahead of the cyclist, when and where would they meet?

Your answer:

What is the relative speed of the runner to the cyclist, the relative speed of the cyclist to the runner and the relative speed of the cyclist to the trees?

Your answer:

**Watch the parabolic animation of someone playing hearts eesh golf is that. Focus Focus Focus.**

PERHATIKAN DENGAN BAIK ANIMASI GERAK PARABOLA BERIKUT

What is the speed and acceleration of the parabola? [view in x and y axis]

Your answer: The Speed of Parabola Motion	Your answer: The Acceleration of Parabola Motion
--	---

What is the speed (v) and position of objects (x) at the maximum height and maximum range?

Your answer:

At maximum height then v:

At maximum height then x:

At maximum range then v:

At maximum range x:

What is the elevation angle so that the object reaches the furthest maximum range?

Your answer:

Activat  
Go to set

FIGURE 3. Examples of worksheet contents

## CONCLUSION

In this study, it can be concluded that kinematics worksheets based instruction virtual phenomenon is very effective with very high category in improving science process skills and conceptual understanding. In addition, the instructions in the worksheet are also easy to understand and there is humor to make it more fun when pre-service physics teachers answer questions. Based on the results of data analysis, it can also be concluded that worksheets based instruction virtual phenomenon very significant to improve science process skills and conceptual understanding of pre-service physics teachers with the medium category because they are trained to improve science process skills and conceptual understanding by answering questions in the worksheet.

## ACKNOWLEDGMENTS

Writers were grateful for those who have supported my research especially my partners (Dwi dan Ernita) for financial aid to conduct this research.

## REFERENCES

1. E. Irwanto, E. Rohaeti, Widjajanti, and Suyanta, "Students' science process skill and analytical thinking ability in chemistry learning," in *The 4th International Conference on Research, Implementation, & Education of Mathematics and Sciences 2017*, AIP conf. series 1868, edited by C. Kusumawardani *et al.* (Yogyakarta State University, Yogyakarta, Indonesia, 2017), pp. 1-5.
2. A. M. Setiawan and Sugiyanto, *J. Pendidik. IPA Indonesia*. **9**, 241–247 (2020).
3. F. D. Syahfitri, B. Manurung and M. Sudiby, *Int. J. Res. Rev.* **6**, 64–74 (2020).
4. K. Manunure, A. Delseireys, and J. Castéra, *Res. Sci. Technol. Educ.* **38**, 289–307 (2020).
5. D. A. Fajarianingtyas, *Indones. J. Sci. Educ.* **4**, 132-138 (2020).
6. A. Halim, Farhan, A. Ahyuni, Susanna, W. Andriani, and Irwandi, "The impact of PhET virtual lab worksheets on student learning outcomes on sound wave materials," in *International Conference on Mathematics and Science education (ICMScE) 2020*, J. Phys. Conf. Series 1806, edited by M. Nurjhani *et al.* (Universitas Pendidikan Indonesia School of Postgraduates, Bandung, Indonesia, 2020), pp. 1-7
7. D. Desriana, I. Khaldun, I. Maulana, Habibati, and A. Ismayani, "The effectiveness of an interactive module in improving students' conceptual understanding of acid-base titration," in *AICMSTE 2019*, J. Phys. Conf. Series 1460, edited by R. Johar *et al.* (Universitas Syiah Kuala, Banda Aceh, Indonesia, 2020), pp. 1-7
8. P. A. Wijaya, A. Widodo, and Muslim, "Virtual experiment of simple pendulum to improve student's conceptual understanding," in *International Conference on Mathematics and Science education (ICMScE) 2020*, J. Phys. Conf. Series 1806, edited by M. Nurjhani *et al.* (Universitas Pendidikan Indonesia School Postgraduates, Bandung, Indonesia, 2021), pp. 1-6.
9. Y. B. R. Widanti and S. Aloysius, "Analysis of science process skills in student worksheet on microorganism topics for senior high school," in *The 5th International Seminar on Science Education 2019*, J. Phys. Conf. Series 1440, edited by Y. Fahmidani *et al.* (Yogyakarta State University, Yogyakarta, Indonesia, 2020), pp. 1-8.
10. G. Sari, M. Hasan, and M. Mahidin, "The development of student worksheet based on predict observe explain to increase students' conceptual understanding of the reaction rates," in *AICMSTE 2019*, J. Phys. Conf. Series 1460, edited by R. Johar *et al.* (Universitas Syiah Kuala, Banda Aceh, Indonesia, 2020), pp. 1-7.
11. M. Y. Afdareza, P. Yuanita, and Maimudah, *J. Educ. Sci.* **4**, 146-152, (2020).
12. I. Patresia, M. Silitonga, and A. Ginting, *Jurnal Pendidik. Biol. Indones.* **6**, 147-156 (2020).
13. L. Zuhriyah and W. Widodo, *J. Penelit. Pendidik. Mat. dan Sains* **3**, 1-4 (2019).
14. D. D. Astuti and D. Hidayat, *J. Holist. Math. Educ.* **3**, 235-248 (2020).
15. O. A. Nanda and I. Wilujeng, *J. Penelit. dan Pembelajaran IPA* **4**, 105-115 (2018).
16. D. Sumardani, A. Putri, Z. Ramadhan, F. Bakri, and D. Mulyati, *J. Pembelajaran Fis.* **8**, 61–70 (2019).
17. E. Sudiby, A. F. Naini, and W. B. Sabtiawan, *J. Penelit. Pendidik. IPA* **4**, 70–74 (2019).
18. H. M, Usman, K. Suyanta, "Virtual lab as distance learning media to enhance student's science process skill during the COVID-19 pandemic," in *SEA-STEM 2020*, J. Phys. Conf. Series 1882, edited by E. Yusibani *et al.* (Universitas Syiah Kuala, Banda Aceh, Indonesia, 2021), pp. 1-8.